

What is claimed is:

1. A modular family of internal combustion engines, wherein:

the family includes at least three engines, each with a different configuration selected from a group comprising single cylinder, V-type, inline, opposed, square, w-type and radial; and

each of the engines includes at least one cylinder, each cylinder of each engine of the family using identical top end component packages.

2. A modular family of internal combustion engines as in claim 1, wherein the engines are all overhead valve, four-stroke engines and the top end component package comprises:

at least one exhaust valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and exhaust valve rocker arm; and

at least one intake valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and intake valve rocker arm.

3. A modular family of internal combustion engines as in claim 2, wherein the top end component package further comprises:

a piston pin;

a small end rod bearing;

a big end rod bearing;

a set of piston rings;

a pair of connecting rod bolts;

a cam chain tensioner;

an exhaust valve hydraulic tappet for each exhaust valve; and

an intake valve hydraulic tappet for each intake valve.

4. A modular family of internal combustion engines as in claim 3, wherein the top end component package further comprises:

a piston; and

a connecting rod.

5. A modular family of internal combustion engines as in claim 4, wherein the top end component package further comprises:

a cylinder head; and

a camshaft.

6. A modular family of combustion engines as in claim 5, wherein the top end component package further comprises:

at least one rocker arm shaft.

7. A modular family of internal combustion engines as in claim 1, wherein the engine configurations comprise at least three from a group comprising: a single cylinder, a V-twin, and an inline twin, and an inline three.

8. A modular family of internal combustion engines as in claim 7, wherein the engine configurations further comprise at least one from a group comprising: a V-six, a V-four and an inline four.

09961338-092501

09961338-092501

9. An engine from a modular family of internal combustion engines, comprising:

at least one cylinder; and

a top end component package associated with the at least one cylinder;

wherein the family includes at least three engines, each with a different configuration selected from a group comprising single cylinder, V-type, inline, opposed, square, w-type and radial; and

wherein each cylinder of each engine of the family uses identical top end component packages.

10. An engine from a modular family of internal combustion engines as in claim 9, wherein all of the engines of the family are overhead valve, four-stroke engines and the top end component package comprises:

at least one exhaust valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and exhaust valve rocker arm; and

at least one intake valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and intake valve rocker arm.

11. An engine from a modular family of internal combustion engines as in claim 10, wherein the top end component package further comprises:

a piston pin;

a small end rod bearing;

a big end rod bearing;

a set of piston rings;

a pair of connecting rod bolts;

a cam chain tensioner;

an exhaust valve hydraulic tappet for each exhaust valve; and

an intake valve hydraulic tappet for each intake valve.

12. An engine from a modular family of internal combustion engines as in claim 11, wherein the top end component package further comprises:

a piston; and

a connecting rod.

13. An engine from a modular family of internal combustion engines as in claim 12, wherein the top end component package further comprises:

a cylinder head; and

a camshaft.

14. An engine from a modular family of internal combustion engines as in claim 13, wherein the top end component package further comprises:

at least one rocker arm shaft.

15. An engine from a modular family of internal combustion engines as in claim 9, wherein the engine configurations comprise at least three from a group comprising: a single cylinder, a V-twin, and an inline twin, and an inline three.

16. An engine from a modular family of internal combustion engines as in claim 15, wherein the engine configurations further comprise at least one from a group comprising: a V-six, a V-four, and an inline four.

17. A method for manufacturing a modular family of internal combustion engines, comprising:

designing a single top end component package; and

designing a single cylinder engine and at least two multiple cylinder engines, each of the multiple cylinder engines having a different configuration selected from a group comprising V-type, inline, opposed, square, w-type and radial;

wherein each cylinder of each engine of the family uses the same top end component package designed in the first step.

18. A method for manufacturing a modular family of internal combustion engines as in claim 17, wherein all of the engines of the family are overhead valve, four-stroke engines and the step for designing the top end component package includes designing the following components of the top end package:

at least one exhaust valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and exhaust valve rocker arm; and

at least one intake valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and intake valve rocker arm.

19. A method for manufacturing a modular family of internal combustion engines as in claim 18, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a piston pin;

a small end rod bearing;

a big end rod bearing;

a set of piston rings;

a pair of connecting rod bolts;

a cam chain tensioner;

an exhaust valve hydraulic tappet for each exhaust valve; and

an intake valve hydraulic tappet for each intake valve.

20. A method for manufacturing a modular family of internal combustion engines as in claim 19, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a piston; and

a connecting rod.

21. A method for manufacturing a modular family of internal combustion engines as in claim 20, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a cylinder head; and

a camshaft.

22. A method for manufacturing a modular family of internal combustion engines as in claim 21, wherein the step for designing the top end component package includes designing:

at least one rocker arm shaft.

23. A method for manufacturing a modular family of internal combustion engines as in claim 17, wherein the step for designing the single cylinder engine and at least two multiple cylinder engines includes designing at least two of the following engine configurations:

a V-twin, an inline twin, and an inline three.

24. A method for manufacturing a modular family of internal combustion engines as in claim 23, wherein the step for designing the single cylinder engine and at least two multiple cylinder engines includes further designing at least one of the following engine configurations:

a V-six, a V-four, and an inline four.

25. A method for reducing a number of unique components required for manufacturing a modular family of internal combustion engines, comprising:

designing a single top end component package;

designing a single cylinder engine and at least two multiple cylinder engines, each of the multiple cylinder engines having a different configuration selected from a group comprising V-type, inline, opposed, square, w-type and radial;

wherein, each cylinder of each engine of the family uses the same top end component package designed in the first step and each component in the top end component package is designed to comply with the strictest performance requirement for that component in any application utilizing one of the family of engines.

26. A method as in claim 25, wherein all of the engines of the family are overhead valve, four-stroke engines and the step for designing the top end component package includes designing the following components of the top end package:

at least one exhaust valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and exhaust valve rocker arm; and

at least one intake valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and intake valve rocker arm.

27. A method as in claim 26, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a piston pin;

a small end rod bearing;

a big end rod bearing;

a set of piston rings;

a pair of connecting rod bolts;

a cam chain tensioner;

an exhaust valve hydraulic tappet for each exhaust valve; and

an intake valve hydraulic tappet for each intake valve.

28. A method as in claim 27, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a piston; and

a connecting rod.

29. A method as in claim 28, wherein the step for designing the top end component package includes designing the further following components of the top end package:

09061338-092501  
TOP SECRET 9060



039619-039621

039619-039621

039619-039621

039619-039621

030619-0307

030619-0307

030619-0307

030619-0307

030619-0307

030619-0307

030619-0307

the family of recreational vehicles encompasses at least two recreational vehicles selected from a group comprising snowmobiles, all terrain vehicles, go carts, personal watercraft, boats with outboard motors, boats with inboard engines, motorcycles, scooters, and light aircraft.

34. One from a family of recreational vehicles as in claim 33, wherein the engines are all overhead valve, four-stroke engines and the top end component package comprises:

at least one exhaust valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and exhaust valve rocker arm; and

at least one intake valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and intake valve rocker arm.

35. One from a family of recreational vehicles as in claim 34, wherein the top end component package further comprises:

a piston pin;

a small end rod bearing;

a big end rod bearing;

a set of piston rings;

a pair of connecting rod bolts;

a cam chain tensioner;

an exhaust valve hydraulic tappet for each exhaust valve; and

an intake valve hydraulic tappet for each intake valve.

0961338-092501

36. One from a family of recreational vehicles as in claim 35, wherein the top end component package further comprises:

a piston; and

a connecting rod.

37. One from a family of recreational vehicles as in claim 36, wherein the top end component package further comprises:

a cylinder head; and

a camshaft.

38. One from a family of recreational vehicles as in claim 37, wherein the top end component package further comprises:

at least one rocker arm shaft.

39. One from a family of recreational vehicles as in claim 33, wherein the engine configurations comprise at least two from a group comprising: a single cylinder, a V-twin, and an inline twin, and an inline three.

40. One from a family of recreational vehicles as in claim 39, wherein the engine configurations further comprise at least one from a group comprising: a V-six, a V-four and an inline four.

41. A family of recreational vehicles sharing a modular family of internal combustion engines, wherein:

the family of engines includes at least two engines, each with a different configuration selected from a group comprising single cylinder, V-type, inline, opposed, square, w-type and radial;

each of the engines includes at least one cylinder, each cylinder of each engine of the family using identical top end component packages; and

the family of recreational vehicles encompasses at least two recreational vehicles selected from a group comprising snowmobiles, all terrain vehicles, go carts, personal watercraft, boats with outboard motors, boats with inboard engines, motorcycles, scooters, and light aircraft.

42. A family of recreational vehicles as in claim 41, wherein the engines are all overhead valve, four-stroke engines and the top end component package comprises:

at least one exhaust valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and exhaust valve rocker arm; and

at least one intake valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and intake valve rocker arm.

43. A family of recreational vehicles as in claim 42, wherein the top end component package further comprises:

a piston pin;

a small end rod bearing;

a big end rod bearing;

a set of piston rings;

a pair of connecting rod bolts;

a cam chain tensioner;

00000000000000000000000000000000

00000000000000000000000000000000

[illegible]

00000000000000000000000000000000

00000000000000000000000000000000

00000000000000000000000000000000

00000000000000000000000000000000

[illegible]

00000000000000000000000000000000

00000000000000000000000000000000

[illegible]

00000000000000000000000000000000

49. A method for manufacturing one from a family of recreational vehicles sharing a family of internal combustion engines, comprising:

designing a single top end component package; and

designing two engines, each having a different engine configuration selected from a group comprising single cylinder, V-type, inline, opposed, square, w-type and radial;

wherein each cylinder of each engine of the family uses the same top end component package designed in the first step; and

wherein the plurality of recreational vehicle types encompasses at least two from a group comprising snowmobiles, all terrain vehicles, go carts, personal watercraft, boats with outboard motors, boats with inboard engines, motorcycles, scooters, and light aircraft.

50. A method for manufacturing one from a family of recreational vehicles as in claim 49, wherein all of the engines of the family are overhead valve, four-stroke engines and the step for designing the top end component package includes designing the following components of the top end package:

at least one exhaust valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and exhaust valve rocker arm; and

at least one intake valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and intake valve rocker arm.

51. A method for manufacturing one from a family of recreational vehicles as in claim 50, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a piston pin;

a small end rod bearing;

a big end rod bearing;

a set of piston rings;

a pair of connecting rod bolts;

a cam chain tensioner;

an exhaust valve hydraulic tappet for each exhaust valve; and

an intake valve hydraulic tappet for each intake valve.

52. A method for manufacturing one from a family of recreational vehicles as in claim 51, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a piston; and

a connecting rod.

53. A method for manufacturing one from a family of recreational vehicles as in claim 52, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a cylinder head; and

a camshaft.

54. A method for manufacturing one from a family of recreational vehicles as in claim 53, wherein the step for designing the top end component package includes designing:

at least one rocker arm shaft.

09961338-092501

55. A method for manufacturing one from a family of recreational vehicles as in claim 49, wherein the step for designing the single cylinder engine and at least two multiple cylinder engines includes designing at least one of the following engine configurations:

a V-twin, an inline twin, and an inline three.

56. A method for manufacturing one from a family of recreational vehicles as in claim 55, wherein the step for designing the single cylinder engine and at least two multiple cylinder engines includes further designing at least one of the following engine configurations:

a V-six, a V-four, and an inline four.

57. A method for manufacturing a family of recreational vehicles sharing a family of internal combustion engines, comprising:

designing a single top end component package; and

designing two engines, each having a different engine configuration selected from a group comprising single cylinder, V-type, inline, opposed, square, w-type and radial;

wherein each cylinder of each engine of the family uses the same top end component package designed in the first step; and

wherein the plurality of recreational vehicle types encompasses at least two from a group comprising snowmobiles, all terrain vehicles, go carts, personal watercraft, boats with outboard motors, boats with inboard engines, motorcycles, scooters, and light aircraft.

58. A method for manufacturing a family of recreational vehicles as in claim 57, wherein all of the engines of the family are overhead valve, four-stroke engines and the step for designing the top end component package includes designing the following components of the top end package:

09961338.092601



at least one exhaust valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and exhaust valve rocker arm; and

at least one intake valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and intake valve rocker arm.

59. A method for manufacturing a family of recreational vehicles as in claim 58, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a piston pin;

a small end rod bearing;

a big end rod bearing;

a set of piston rings;

a pair of connecting rod bolts;

a cam chain tensioner;

an exhaust valve hydraulic tappet for each exhaust valve; and

an intake valve hydraulic tappet for each intake valve.

60. A method for manufacturing a family of recreational vehicles as in claim 59, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a piston; and

a connecting rod.

09961338-092501

09961338-092501  
TOP SECRET

61. A method for manufacturing a family of recreational vehicles as in claim 60, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a cylinder head; and

a camshaft.

62. A method for manufacturing a family of recreational vehicles as in claim 61, wherein the step for designing the top end component package includes designing:

at least one rocker arm shaft.

63. A method for manufacturing a family of recreational vehicles as in claim 57, wherein the step for designing the single cylinder engine and at least two multiple cylinder engines includes designing at least one of the following engine configurations:

a V-twin, an inline twin, and an inline three.

64. A method for manufacturing a family of recreational vehicles as in claim 63, wherein the step for designing the single cylinder engine and at least two multiple cylinder engines includes further designing at least one of the following engine configurations:

a V-six, a V-four, and an inline four.

65. A method for reducing a number of unique components required for manufacturing a family of recreational vehicles sharing a family of internal combustion engines, comprising:

designing a single top end component package; and

designing a single cylinder engine and at least one multiple cylinder engine with a configuration selected from a group comprising V-type, inline, opposed, square, w-type and radial;

wherein each cylinder of each engine of the family uses the same top end component package designed in the first step and each component in the top end component package is designed to comply with the strictest performance requirement for that component in any application utilizing one of the family of engines; and

wherein the plurality of recreational vehicle types encompasses at least two from a group comprising snowmobiles, all terrain vehicles, go carts, personal watercraft, boats with outboard motors, boats with inboard engines, motorcycles, scooters, and light aircraft.

66. A method as in claim 65, wherein all of the engines of the family are overhead valve, four-stroke engines and the step for designing the top end component package includes designing the following components of the top end package:

at least one exhaust valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and exhaust valve rocker arm; and

at least one intake valve, valve seat, valve guide, valve stem seal, valve spring, valve spring retainer and intake valve rocker arm.

67. A method as in claim 66, wherein the step for designing the top end component package includes designing the further following components of the top end package:

a piston pin;

a small end rod bearing;

a big end rod bearing;

a set of piston rings;

a pair of connecting rod bolts;

[illegible][illegible][illegible]

**000000000000**

[illegible][illegible][illegible][illegible]

**00000000000000000000**

**00000000000000000000**

**00000000000000000000**

[illegible]

**00000000000000000000**

72. A method as in claim 71, wherein the step for designing the single cylinder engine and at least two multiple cylinder engines includes further designing at least one of the following engine configurations:

a V-six, a V-four, and an inline four.

09961338-092501